

Association between the Independent Variables with Knowledge Level of Adopter and Non-adopter Farmers about the Solar-powered Water Pumping System in Rajasthan

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Renewable energy stands as the most abundant energy source globally. Solar energy emerges not only as a solution to the present energy crisis but also as an environmentally friendly energy source. Photovoltaic (PV) generation represents an efficient method for harnessing renewable energy. Solar energy (Saur Urja) is a clean and green source of energy. Solar water pumps are used for irrigation of crops, water for livestock and provide portable drinking water. The Rajasthan government has announced a subsidy of up to 60 per cent on solar pumps ranging from 3 HP to 10 HP for farmers as part of the Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyaan (PM-KUSUM) program for the year 2023-24. The present study was undertaken to Association between the Independent Variables with Knowledge Level of adopter and non-adopter farmers about the solar-powered water pumping system in Rajasthan. Three districts were selected purposively and two villages were selected randomly from each of the three districts in the state of Rajasthan. A total of 40 farmers from each of three districts were selected, and from each of 6 villages, 10 farmers who adopted SPWP and 10 who did not adopt SPWP were selected to measure knowledge, attitude and training needs. As a result, the researcher carried out personal meetings with 120 farmers at their farms or homes. The independent variable income ($r=0.328$), social participation ($r=0.3541$), and knowledge of government policies ($r=0.331$) variable was strongly positive correlation with significant at 0.01% of adopters, whereas source of irrigation ($r=-0.268$) were positive correlation with significant at 0.05% of knowledge level of non-adopter farmers.

Keywords: Solar, pump, energy, farmers, knowledge, adopter, correlation

Renewable energy stands as the most abundant energy source globally. Solar energy emerges not only as a solution to the present energy crisis but also as an environmentally friendly energy source. Photovoltaic (PV) generation represents an efficient method for harnessing renewable energy. Solar panels, comprising arrays of PV cells, are now widely deployed for illuminating street lights, powering water heaters and meeting household energy demands. The decreasing cost of solar panels continually encourages their adoption across various sectors. Among its applications, solar-

powered irrigation systems have gained traction among farmers, presenting a sustainable solution amidst India's energy challenges. According to the Renewables Global Status Report 2023, solar PV dominated global renewable power growth in 2022, accounting for 70 per cent (243 GW) of the total 348 GW capacity additions, which represented an approximate 37 per cent increase compared to 2021. This expansion was followed by wind power at 77 GW (22 per cent) and hydropower at 22 GW (6.3 per cent), with China, the United States, and India emerging as the top three countries for solar and wind capacity additions. Out of the total new solar capacity, China installed 44 per cent, while the United States and India each captured an 8 per cent share. Concurrently, India maintains a strong global position in the sector, ranking third in renewable energy attractiveness behind China and the US, and fourth in overall installed renewable energy capacity following China, the US, and Brazil.

Solar energy (Saur Urja) provides a clean, green, and cost-effective power source for solar water pumps, which are increasingly preferred over expensive, high-maintenance diesel pumps for crop irrigation, livestock watering, and delivering portable drinking water. Because peak solar array output naturally aligns with high summer water demands, these systems efficiently maximize energy use, often employing storage tanks to capture excess water during cloudy periods. Beyond eliminating the need for fuel and constant maintenance, solar water pumps offer operational independence from the electrical grid and can even be designed for portability to adapt to changing seasonal requirements or shifting water demands.

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Roughly 70 per cent of India's population relies on agriculture, either directly or indirectly. Among the 140 million sown hectares, 44 per cent depend on irrigation, while the remainder relies on the monsoon. Irrigation is crucial for food crops. The majority of electricity consumed in the agricultural sector is dedicated to operating pump sets for irrigation. According to the latest data yearbook released by The Energy Research Institute (TERI), the portion of direct energy consumption in the agriculture sector of India, in the form of electricity, increased from 28.75 percent in 2009-10 to 37.1 percent in 2019-20, out of the total energy consumption (Business Standard, 21 September 2023). India possesses approximately

Under the Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyaan (PM-KUSUM) program for the year 2023-24, the Rajasthan government has announced a subsidy of up to 60 percent on solar pumps ranging from 3 HP to 10 HP for farmers. For solar pump capacities between 3 HP and 7.5 HP, the Ministry of New and Renewable Energy (MNRE) and the state government will each contribute a 30 percent subsidy to cover 60 percent of the total cost, leaving farmers responsible for the remaining 40 percent. For farmers opting for a 10 HP capacity solar pump, subsidies will only apply to the amount equivalent to a 7.5 HP capacity pump, with the remaining cost borne by the farmer. Between 2020 and 2023, Rajasthan witnessed the installation of the highest number of solar pumps, totaling 3,79,472 (Source: Pant Krishi Bhawan, Jaipur, 2024).

The present study focuses on conducting a comparative analysis of the adopters and non-adopters of solar-powered water pumping systems in the states of Haryana and Rajasthan, both located in northern India. Haryana and Rajasthan face similar challenges, such as groundwater depletion, unreliable grid electricity supply and the need for sustainable agricultural practices. However, the two states differ in terms of socio-economic factors, agricultural practices and policies related to renewable energy adoption. Therefore, a comparative study can provide valuable insights into the factors influencing the adoption of solar-powered water pumping systems in diverse contexts.

Objectives of the Study

- To assess the knowledge of adopters and non-adopters of solar powered water pumping system.
- To know the attitude of adopter and non-adopter farmers towards the solar-powered water pumping system.
- To identify the constraints perceived by the adopter and non-adopter farmers' adoption of the solar-powered water pumping system.
- To ascertain the training needs of adopter and non-adopter farmers of the solar-powered water pumping system.

Method

This study was purposively conducted in the Sriganganagar, Bikaner, and Jaipur districts of Rajasthan due to their high concentration of farmers utilizing solar photovoltaic water pumps (SPWP); from each of these three districts, two villages were randomly selected, establishing a total of six villages for data collection. Out of these 10 agricultural regions of Rajasthan, Bikaner, Jaipur and Sriganganagar districts were selected purposively with the maximum number of beneficiary farmers who

had installed SPWP.

In the Sriganganagar district, the following villages were selected, namely, Fakirawali and Ganeshgarh; from Bikaner district, Rojha and Pemasar; and from Jaipur district, Hirnoda and Renwal. A total of 40 farmers from each of the three districts were selected, and from each of 6 villages 10 farmers who adopted SPWP and 10 who did not adopt SPWP were selected to measure knowledge, attitude and training needs. As a result, the researcher carried out personal meetings with 120 farmers at their farms or homes.

Measure

The interview schedule was developed after an extensive review of the relevant literature and consultation with experts in Agricultural Extension and Renewable Energy. The instrument was pre-tested with a small group of respondents outside the study area to ensure clarity, relevance, and comprehensibility.

Procedure

To collect data for the study, a well-structured interview schedule was prepared and administered through separate, personal interviews with respondents at their farms and homes to assess their socioeconomic status, knowledge, adoption levels, and constraints. Subsequently, farmers were categorized into adopters and non-adopters of solar-powered water pumping systems. Finally, ten adopters and ten non-adopters were selected randomly from each village, resulting in a total sample of 120 respondents.

Statistical Analysis

The data collected from the respondents' schedules were suitably coded and analyzed using descriptive and inferential statistical tools. Frequency, percentage, mean, and standard deviation were employed to describe the respondents' characteristics, while Pearson's correlation coefficient was used to examine the relationships between the independent variables and knowledge level. Multiple regression analysis was performed to identify the significant predictors influencing the knowledge level of adopters and non-adopters of solar-powered water pumping systems.

Results and Discussion

The given data in Table 1 appeared to represent the correlation coefficients (r-values) between various independent variables and two groups of participants: SWPS adopters and SWPS non-adopters. The correlation coefficients indicated the strength and direction of the relationship between each independent variable and the knowledge of SWPS.

It can be concluded from Table 1 that out of 15 independent variables, SWPS adopters' age had a negative correlation ($r = -0.135$), cast ($r = -0.070$), family size ($r = -0.031$), and farm machinery ($r = -0.153$) had negative correlations with knowledge level, and non-significant but risk orientation ($r = -0.147$) was non-significant and positive correlation with knowledge level of SWPS adopters.

The education variable ($r = 0.257$), land holding ($r = 0.264$), cropping system ($r = 0.299$), mass media exposure ($r = 0.253$), extension contact ($r = 0.262$), innovativeness ($r = 0.256$) and source of irrigation ($r = 0.273$) variable were positive correlation with

knowledge level of adopter SWPS with the significant at 0.05% whereas income ($r=0.328$), social participant ($r=0.3541$) and knowledge of govt. policies ($r=0.331$) variable was strongly

positive correction with significant at 0.01%. These results are in conformity with the results of (Savitharamma, 2011; Dalip, 2021; Shen et al., 2015; Kumar et al., 2018; & Ramrao, 2018).

Table 1

Relationship between Selected Independent Variables and Knowledge Level of Respondents towards SWPS in Rajasthan

S. No.	Independent Variables	SWPS Adopters (n=60)	SWPS Non-adopters (n=60)
		Correlation coefficient (r)	Correlation coefficient (r)
1.	Age	-0.135 NS	0.107 NS
2.	Caste	-0.070 NS	0.047 NS
3.	Education	0.257 *	0.251 *
4.	Family size	-0.031 NS	0.110 NS
5.	Income	0.328 **	0.262 *
6.	Landholding	0.264 *	0.222 NS
7.	Cropping system	0.299 *	0.014 NS
8.	Social participation	0.341 **	0.269 *
9.	Mass media exposure	0.253 *	0.054 NS
10.	Extension contact	0.262 *	0.270 *
11.	Innovativeness	0.256 *	0.051 NS
12.	Knowledge of Govt. policies	0.331 **	0.269 *
13.	Farm machinery	-0.153 NS	0.058 NS
14.	Source of irrigation	0.273 *	0.268 *
15.	Risk orientation	0.147 NS	0.013 NS

Note. * Significant at 0.05%, Significant at 0.01% and NS= Non Significant

Among non-adopters of SWPS, age ($r=0.107$), cast ($r=0.251$), family size ($r=0.110$), land holding ($r=0.222$), cropping system ($r=0.014$), mass media exposure ($r=0.054$), innovativeness ($r=0.051$), farm machinery ($r=0.058$) and risk orientation ($r=0.013$) were positive correlations but education ($r=0.251$), income ($r=0.262$), social participant ($r=0.269$), extension contact ($r=0.270$), knowledge of govt. policies ($r=0.269$) and source of irrigation ($r=0.268$) were positive correlation with significance at 0.05% of knowledge level of non-adopter farmers. The aforementioned result aligns with the research conducted by Naseem et al (2016), Shen et al. (2015) and Sowjanya (2014).

Multiple Regression Analysis between Independent Variables and the Knowledge Level of Respondents towards SWPS in Rajasthan

In Table 2, multiple regression analysis revealed from a first glance that at the 0.01 and 0.05 level of probability, it was discovered that education, income, landholding, cropping system, social participation, mass media exposure, extension contact, knowledge of Govt. schemes, and innovativeness all had positive and significant regression coefficients. With the knowledge of SWPS adopter farmers, it was discovered that age, caste, family size, farm machinery, and risk orientation had positive but non-significant regression coefficients. Further evidence may be seen in Table 2, which demonstrates that all background variables together accounted for 66.13 per cent of the difference in adopter farmers' knowledge. At the 0.01 and 0.05 levels of probability, it was determined that the estimated "F" value was significant. That was to

say, one unit change in the degree of education, income, landholding, cropping system, social participation, mass media exposure, extension contact, knowledge of Govt. schemes and innovativeness resulted in a comparable change in the farmers who adopted the SWPS in terms of their knowledge. However, in the case of non-adopters, age, caste, family size, landholding, cropping system, innovativeness, knowledge of Govt policies, farm machinery, and risk orientation were found to have positive but non-significant relationships, whereas education, income, social participation, mass media exposure, extension contact and source of irrigation were found to have positive and significant relationships. The regression coefficient also revealed that the background variables as a whole explained 54.33 per cent of the variation in SWPS's non-adopter farmers. A 0.05 level of probability was used to determine whether the estimated "F" value was significant. The results were supported by Kumar et al. (2018).

The positive association between education and knowledge may be attributed to the greater ability of educated farmers to access, understand, and utilize technical information related to solar-powered irrigation technologies. Similarly, farmers with higher income levels may possess greater financial capacity to obtain information, participate in training programmes, and adopt innovative agricultural technologies. The significant influence of extension contact and mass media exposure emphasizes the importance of agricultural extension services and communication channels in enhancing farmers' awareness regarding government schemes and renewable energy technologies

Table 2

Multiple Regression Analysis between Independent Variables and Knowledge Level of Respondents towards SWPS in Rajasthan (n=120)

S. No.	Independent variables	SWPS Adopters (n=60)			SWPS Non-adopters (n=60)		
		Regression coefficient			Regression coefficient		
		b-value	t-value	p-value	b-value	t-value	p-value
1.	Age	-0.083	-1.515	-0.136NS	0.068	0.775	0.441NS
2.	Caste	-0.128	-0.345	-0.731NS	0.393	0.680	0.499NS
3.	Education	1.520	1.515	0.036*	0.191	0.319	0.043*
4.	Family size	0.188	0.374	0.709NS	1.299	1.696	0.096NS
5.	Income	0.033	0.045	0.041*	1.523	1.120	0.044*
6.	Landholding	0.157	0.161	0.020**	-0.938	-0.496	-0.621NS
7.	Cropping system	0.383	0.701	0.032*	-0.792	-0.897	-0.374NS
8.	Social participation	0.883	1.434	0.015**	0.489	0.332	0.040*
9.	Mass media exposure	0.314	1.039	0.040*	0.166	0.641	0.024*
10.	Extension contact	0.233	0.675	0.031*	0.724	2.470	0.017**
11.	Innovativeness	0.117	0.778	0.045*	0.044	0.282	0.778NS
12.	Knowledge of Govt. policies	0.059	0.116	0.038*	0.271	0.426	0.671NS
13.	Farm machinery	0.433	1.576	0.122NS	0.491	1.142	0.259NS
14.	Source of irrigation	0.104	0.223	0.024*	0.869	1.387	0.027*
15.	Risk orientation	0.345	1.201	0.236NS	0.142	0.537	0.593NS
	R ²		0.6613				

Note. Significant at 0.05%, ** Significant at 0.01% and NS = Non Significant

Conclusion

The study concludes that farmers' knowledge regarding solar-powered water pumping systems is significantly influenced by several socio-economic and institutional factors, particularly education, income, social participation, extension contact, mass media exposure, and awareness of government policies. Strengthening agricultural extension services, improving farmers' access to reliable information, and enhancing awareness of government support programmes are essential for promoting the adoption and sustainable utilization of solar-powered irrigation technologies. The findings provide useful insights for policymakers and extension agencies in designing effective interventions to accelerate the transition towards sustainable and climate-resilient agriculture in Rajasthan

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